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MODERN GEOLOGISTS AND THE "OLD MASTERS."

Ice or Water. Another Appeal to Induction from the Scholastic Methods of Modern Geology. By Sir Henry H. Howorth, K.C.I.E., D.C.L., F.R.S., V.P.S.A., F.G.S. Vol. i. Pp. xlvi+536. Vol. ii. Pp. viii+498. (London: Longmans and Co., 1905.) Price 32*s.* net.

THE two volumes before us must be regarded as parts of a complete work in which the author has set himself the task of disproving the usually accepted glacial theory. As he himself says in his preface, "the two volumes now published contain a large part of, though not all, my supplementary arguments against the glacial theory; a portion being still reserved for a succeeding volume which will also contain an enlarged presentation and justification of the theory I substituted for it in my 'Glacial Nightmare,' namely, the diluvial theory."

In the volumes under review the subject-matter may be considered under three heads:—(1) the theories which have been proposed to account for Glacial periods; (2) the efficiency of water as an agent of erosion; (3) the capacity of ice to produce the effects which have been assigned to it by modern geologists.

(1) *Theories of an Ice Age.*—The four opening chapters of the first volume are devoted to a criticism of the various theories, astronomical and geographical, which have been put forward in attempts to solve the problem of the Great Ice Age and of former periods of glaciation. Sir Henry is ever skilful in detecting the weak points in his opponents' armour, and here, as in his book on the "Glacial Nightmare," he has an imposing array of objections raised by others and himself to the various explanations which have been offered.

Our present inability to offer any adequate explanation of the Glacial period seems to be largely recognised; as Prof. Chamberlin has said, "The riddle remains to be read." This grieves the author greatly, perhaps unduly.

"It is not encouraging," he says, "to read of a succession of failures by men of parts and ingenuity in futile efforts to solve what is apparently an insoluble problem; to measure the waste of thought and time and oil involved in these efforts of the geological Sisyphus to roll the glacial snowball on to some stable foothold, and to see it roll down the hill in every case into the abyss where so many scientific hopes and efforts lie buried."

But is the waste so complete as the author seems to imply? Though the riddle is not yet read, the number of facts which have been garnered during the process of testing the inadequate explanations remain for use when seeking the correct solution, and many a minor point has already been settled.

The occurrence of Glacial periods is not the only climatic problem to which the geologist is without clue. We have not yet explained the existence of beds containing rich floras in Greenland. To the ordinary geologist the evidence for a Glacial period is as strong as that for the former occurrence of warmer conditions in Greenland, and he is hardly likely to reject the evidence in the former case any more than in the latter, simply because he has not yet arrived at an adequate explanation of the phenomena.

(2) *The Efficiency of Water as an Agent of Erosion.*—The author devotes several chapters to a discussion of the potency of the various agents of subaërial and marine erosion under existing conditions, and refuses to recognise the efficiency of these agents to do the work claimed for them by the great number of living geologists. He supports his arguments by a large number of quotations from various writers, ancient and modern, great and small. But we look in vain for any recognition of the principles of erosion which were laid down by G. K. Gilbert in his "Geology of the Henry Mountains," and form the basis of modern writings on erosion. He quotes Mr. Harker's paper on the subaërial denudation of Skye (*Geol. Mag.*, 1899, p. 485) to show that in that district "the agents of atmospheric degradation, erosion and transportation, are at the present time almost wholly inoperative," but ignores that writer's statement concerning the great erosion of the district in Tertiary times. Sir Henry, in fact, does not seem to have recognised the importance of the "base-line of erosion" as one of the controlling factors in the sculpture of a district, and this vitiates many of the arguments advanced in this section of the book.

But there is much in this section that is suggestive, especially the portions dealing with the effects of earth-movement and fracture in the production of valleys. In the "heroic age" of geology too much influence was undoubtedly assigned to these effects in accounting for valley-formation, and one cannot but feel that with the swing of the pendulum, and owing to the importance which geologists now attach, and rightly attach, to agents of erosion, the influence of movement accompanied by fracture, at any rate as an indirect factor, has been unduly minimised.

(3) *The Capacity of Ice to Produce the Effects Assigned to it.*—In the two concluding chapters of vol. i. and in the greater part of vol. ii., Sir Henry is directly at issue with the modern geologists, for in the majority of the phenomena which have been appealed to in support of the operations of ice he refuses to see any signs of ice-work. Notwithstanding the ingenuity with which he argues, we cannot see that he makes out a case. The Glacial period has been established as the result of cumulative evidence, and although there are many differences of opinion on minor points, geologists are agreed as to the occurrence of such a period in late Tertiary times in consequence of what most of them consider to be overwhelming evidence.

Here we must insert a word concerning the author's "old masters." In vol. i., p. 213, he takes his stand "with the old masters, Hopkins and Whewell, Conybeare, Sedgwick and Murchison. These men knew something more than geology; they were mathematicians and physicists as well." Again, on p. 460 he says:—"I do not hesitate myself to confess, and to be proud of the confession, that I

believe in the old men rather than in the new." It is true that in these cases he is referring to special points, but again and again one cannot but feel in reading the book that the writer pays undue regard for authority, without considering that his "old masters" were not acquainted with all the facts which we now possess, and that they themselves changed their views. Sedgwick, for instance, came to believe in an Ice age. Moreover, if these were old masters, so were Hutton and Playfair, Lyell and Buckland, whose views are not always so palatable to the author. It may be remarked, also, that a knowledge of mathematics and physics was not confined to the geologists of those days. One of the most ardent of the existing advocates of ice-erosion, concerning whose paper on ice action in Skye (*Trans. Roy. Soc. Edin.*, vol. xl., 1901) Sir Henry is silent in these two volumes, was a high wrangler, and took a first class in physics at Cambridge.

The theory of an Ice age was largely put forward owing to the existence of rounded and striated rock-surfaces and scratched and polished boulders. These resemble similar productions of modern ice to such a degree that the geologist has no more hesitation in referring them to ice-action than he has to assign the formation of the pebbles of a river to stream-action. The inference drawn from the existence of these phenomena has been supported by a host of other observations, biological as well as physical, and if Sir Henry should succeed in disproving the existence of an Ice age he will also break down the essential principle of geology, "that like effects imply like causes."

It would be impossible in a brief article to discuss all the questions raised in this part of the work. We must content ourselves with a few observations. Though reference is made now and again to the Greenland ice and to the ice masses of Spitsbergen, it is the glaciers of the alpine type to which most frequent appeal is made. To this we shall recur, but in the meanwhile would invite the author's attention to yet another treatise concerning which he is silent, where another type of ice work is described, namely, I. C. Russell's volume on the Malaspina Glacier (thirteenth annual report of the U.S. Geological Survey).

When describing the Till or Boulder-clay, the author quotes a description of it by Prof. James Geikie, and goes on to observe, "this being without question the most typical of so-called glacial deposit, it is a remarkable fact that no such deposit is now being made, so far as we know, by land-ice anywhere." He must have overlooked a passage in a paper to which he elsewhere refers, by Messrs. Garwood and Gregory, on the glacial geology of Spitsbergen (*Quart. Journ. Geol. Soc.*, vol. liv.). They say:—

"On the broad plain at the foot of Booming Glacier we found some square miles of a tough mud containing boulders and pebbles; it only needed to be dried and hardened to form an ideal Boulder Clay. Clearly this deposit had been laid down by land-ice."

The author objects to the sharp line which is drawn by many geologists to show the margin of the ice at its period of maximum extension, and denies the existence of any evidence for this, arguing that the Boulder-clay, the masses of gravel and loam, and the loess are genetically connected. Of this we shall doubtless hear more when the third volume appears.

Much is naturally made of the conflict of opinion among geologists concerning the occurrence of inter-Glacial periods, and the relative importance of land-ice and floating-ice in producing the phenomena generally taken to indicate the occurrence of a Glacial period. These questions are certainly not settled to everyone's satisfaction, but they in no way invalidate the conclusions which have been drawn as to the existence of an Ice age.

Though we do not agree with the author in his main conclusions put forward in this section of the work, we must admit that much that he writes is worthy of consideration, even though his views seem exaggerated. For instance, he argues that much of the material forming the drifts was broken up prior to the so-called Ice age, and this we believe to be true, even though the breakage did not occur in the manner advocated elsewhere by the author; but if true, it invalidates the appeal to modern Alpine glaciers to prove the inadequacy of ice as an erosive agent. The loose materials ready to hand at the beginning of Glacial times would supply the ice with the tools for rasping and grinding. As that material became comminuted, unless new material was supplied in abundance, the ice would become less effective as an eroder. Also ice, like water, has a base line of erosion beneath which it cannot work. This line may have been reached in the case of Alpine glaciers, and the supply of material to the sole have been also largely diminished, in which case one can no more argue from what Alpine glaciers are now doing as to the effects of land ice in the Glacial period than one can explain the cañons of the Colorado by reference to a little stream which has established its base level.

Throughout the work much has been made of the conflicting views of geologists as to the details of ice action. Sir Henry is obviously greatly impressed with the fact that in the long and arduous attempt to unravel the Gordian knot the skein sometimes seems to have become hopelessly twisted; but he who carefully studies the process of disentanglement sees that, notwithstanding the many kinks, the tangle is becoming less. The author, impatient of the slow process, has elsewhere attempted to cut the knot, and will evidently give reasons for this act in the third volume. We fear that the attempt will not be regarded as successful, either by the "ultra-glacialists" or by geologists in general.

We cannot recommend the book to geological babes and sucklings, but it will well repay perusal by the advanced reader. He will forgive the "energetic adjectives and adverbs," which are hardly necessary to a calm and dispassionate discussion, on reading the author's frank apology in the preface. The store of facts collected in the book is of the utmost value

to the student of glacial geology, though we wish that references to the original memoirs had been in all cases added. There are, as we have tried to show, many valuable criticisms and suggestions contained in the work. Lastly, it will prove a useful intellectual exercise to weigh the author's arguments in the balance. For these reasons we believe that readers who have an extensive acquaintance with the facts and principles of geology will read the book with profit—and with pleasure. J. E. M.

PHYSICAL CHEMISTRY.

Theoretical Chemistry. By Prof. Walther Nernst. Revised in accordance with the fourth German edition. Pp. xxiv+771. (London: Macmillan and Co., Ltd., 1905.) 15*s.* net.

THE fact that three further editions of the German text of Nernst's well known treatise on theoretical chemistry have been called for since the appearance of the original in 1893, affords ample testimony to its intrinsic merits. An English translation of the first edition by Prof. C. S. Palmer appeared in 1895, and this, until now, has been the only English version.

During the last ten years much valuable work has been carried out in the province of physical chemistry, and the publishers have recognised the necessity of bringing the English edition up to date. With that object Dr. R. A. Lehfeldt has translated the whole of the new matter contained in the fourth German edition and has revised certain parts of the original translation.

It has been the reviewer's experience to hear the original translation adversely commented upon, and it is perhaps to be regretted that the bulk of the old text remains as it was in the first edition. After careful perusal of the work, it is indeed difficult to suppress the feeling that a better result would have been attained by an entirely new translation of the fourth German edition.

Two new chapters in the work under review deal with "The Atomistic Theory of Electricity" and "The Metallic State." In the first of these an account is given of the electron theory and of the phenomena of ionisation and electric conduction in gases. In the second the nature of the metallic condition is discussed on the basis of results which have been obtained by the study of the freezing point curves and of the electrical conductivity of mixtures of metals. These chapters form very interesting reading, although, of course, it has not been possible within the compass of seventeen pages to give more than the briefest outline.

The space given to electro-chemistry has been extended from 26 to 46 pages, and the exposition of the subject-matter greatly improved. The application of thermodynamics and of the osmotic theory to electro-chemical systems is now treated in separate chapters, and many new observations bearing on the theory of electrolysis have been incorporated.

It is not possible to mention more than a few of the alterations and additions which have been made in the text generally. One notes with pleasure that the somewhat abstruse exposition of energy relationships in the introductory chapter has been made more lucid. The discovery of the inert gases of the argon series has led to much discussion of late years in reference to the periodic classification of the elements, and these recent views are summarised in the chapter on the atomic theory.

Other important new sections deal with Werner's theory of molecular compounds, catalysis, the mechanism of autoxidation processes, tautomerism, and the kinetics of heterogeneous systems. The view that tautomerism is due to the co-existence in dynamic equilibrium of mutually transformable isomeric substances seems to be very probable in the light of recent work. In this connection the interesting observations of Hantzsch on the transformation of the tautomeric forms of nitrophenylmethane and similar bodies are recorded, but one looks in vain for any reference to Lowry's investigations on dynamic isomerism. In reference to the kinetics of heterogeneous systems and the mechanism of chemical change, it is now recognised that many gaseous reactions, usually regarded as taking place in a single phase, are possibly examples of changes essentially conditioned by phenomena at a boundary surface. The rate at which arsine or phosphine decomposes is in accord with the formula for a unimolecular change, but this agreement really affords no conclusive argument with reference to the mechanism of the change. The measured rate of change has possibly nothing whatever to do with the chemical change involved, but merely with a physical change at the surface of the containing vessel. In a third edition reference should be made to this in the section dealing with the mechanism of reactions on pp. 562–564.

Of necessity, much new work has had to be left unmentioned in the new edition, but the author is to be congratulated on the large amount of new matter which he has been able to introduce without appreciable alteration in the size of the volume. With the issue of this second edition one may confidently anticipate that Nernst's book will still maintain its position as one of the classics of theoretical chemistry. H. M. D.

STOKES'S MATHEMATICAL AND PHYSICAL PAPERS.

Mathematical and Physical Papers by the late Sir George Gabriel Stokes, Bart. Vol. v. Pp. xxv +370. (Cambridge: The University Press, 1905.) Price 15*s.*

THE speedy completion of the reprint of Stokes's papers is matter of congratulation to the distinguished editor, to the Cambridge Press, and to all students of mathematical physics. The general character of the contents of this concluding instalment is sufficiently described in the following extract from Prof. Larmor's preface:—

"It will be observed that the present volume represents the period in which Sir George Stokes' scientific activities were mainly expended in the work of the Royal Society and of public Scientific Committees,